Assessment of land surface hydrologic predictability in the NAME region using a derived long-term land surface data set

YEAR 2 PROGRESS REPORT

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This report summarizes work at the University of Washington during the second year of the subject project. We list at the end of this report one journal article that is in press *Journal of Climate*, another *Journal of Climate* paper in preparation, and a conference presentation. The primary activities conducted during the past fiscal year are summarized below in sections describing the two ongoing tasks.

Tasks 1 and 2: Produce long-term hydrological dataset of land surface fluxes and states for Mexico and execute real-time re-run of LDAS soil moisture over NAME Tiers 1 and 2 for the NAME summer 2004 field experiment period.

We proposed to extend the retrospective LDAS data set of Maurer et al (2002) to cover all of NAME Tiers 1 and 2. For retrospective runs, the main sources of station data over Mexico are ERIC2 (1940-1998; a product from Mexican Institute of Technology of Water (IMTA) of the SEMARNAP) for daily precipitation and temperature data, and a CD produced by SMN (Servicio MeterorolÓgico Nacional, 2000) with some stations dating back as far as 1915. SMN daily historical precipitation data (provided courtesy of Miguel Cortez Vázquez of SMN) are also a data source for 1995 – near real-time. After doing some simple data checks (e.g. impossible values, out of range values, etc.), we combined these raw station data sets and gridded them using the SYMAP method also employed by Maurer et al (2002) to produce a long-term gridded daily precipitation and temperature dataset (1925-2003) at 1/8 degree spatial resolution over all of Mexico. The long-term annual mean precipitation and daily mean temperature spatial patterns show reasonable features with lower precipitation in desert region and higher magnitudes in coastal and southern Mexico, and lower temperature over mountainous areas and higher values near the coast especially in southern Mexico. We also compared the annual daily mean temperature with SMN climatologic Tmean over selected state capitals. In most places, the difference is less than one degree C. (**http://smn.cna.gob.mx/productos/normales/medias.html**)

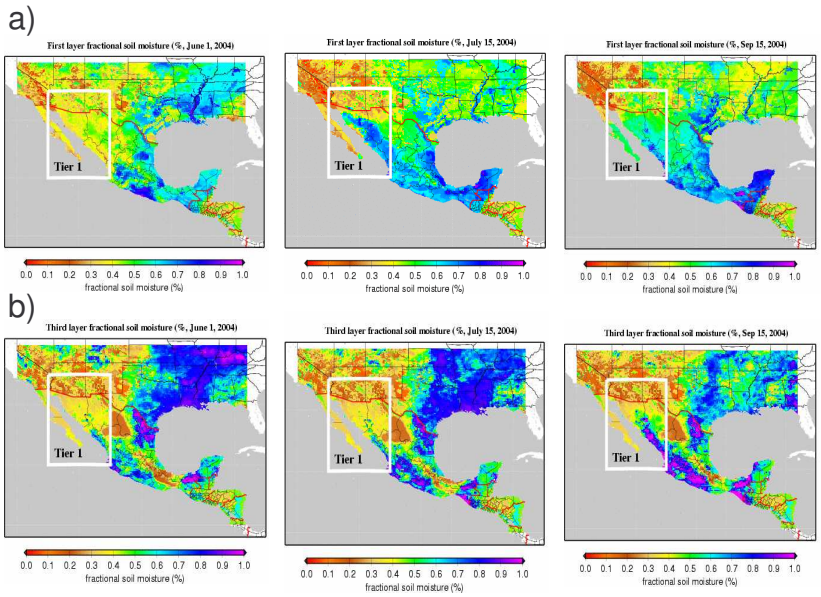

Figure 1: Fractional soil moisture map: a) first layer b) second layer

Using Banco Nacional de Datos de Aguas Superficiales (BANDAS) (from CAN and IMTA) streamflow data, we compared simulated and observed streamflow over selected river basins to calibrate the VIC soil moisture parameters. Because nearly all of the larger basins are regulated, we selected 15 comparatively

small basins (less than 10,000 km^2) with long-term records during the period 1970-1990 (which has the highest precipitation gauge station density) distributed over Mexico. In most cases, simulated hydrographs show reasonable correspondence with observations, although there are substantial errors in some cases. Recognizing that the raw station data are not of very high quality especially when focusing on relatively small areas, we take the results as confirmation that the large area VIC-derived data set does a plausible job of partitioning precipitation into runoff and evaporation. Based on the calibrated parameters and the gridded meteorological dataset, we performed a long-term retrospective VIC simulation (1950-2002) over Mexico to simulate the water (soil moisture, runoff, evaporation) and energy ground heat, latent and sensible heat fluxes) storages and balances. This data set will be used in our ongoing analysis of land surface feedback mechanisms in the NAMS core region (Northwestern Mexico) shown in a later section.

The real-time VIC rerun for summer 2004 uses CPC real-time daily precipitation analysis data and the NW Mexico NAME Event Rain gage Network (NERN) precipitation daily data. The latter is a network installed specifically for NAME; it includes 86 stations mostly along a series of east-west transects along the Sierra Madre. The temperature and wind data are taken from the real-time Eta 4-D Data Assimilation System (EDAS) 3hourly dataset. We used a spinup period of 1.5 years to remove the effects of soil moisture initial conditions. The summer 2004 LDAS re-run is for the period June 1 - Sep. 15, and is archived in **ftp://ftp.hydro.washington.edu/pub/chunmei** (arrangements are underway to have the data permanently archived at JOSS). The simulated fractional soil moisture (Fig.1) shows reasonable temporal variation during 2004 summer in NW Mexico. The first soil layer reflects dry conditions before the onset of the monsoon, wet conditions during the monsoon, and the beginning of drying at the end of the monsoon. The third layer is nearly fully recharged by the end of the monsoon season in NW Mexico, reflecting the strong 2004 monsoon that was observed over much of the region.

Task 3: Data analysis and interpretation: Predictability analysis

This task is intended, in part, to explore the role of the land surface (soil moisture in particular) in NAMS teleconnections. We have explored possible links between NAMS seasonal (JJAS) precipitation and pre-monsoon seasonal land surface conditions, including precipitation, temperature, soil moisture anomalies. We have evaluated the possible effects of the previous winter and spring's land surface conditions on Monsoon South (Northwestern Mexico) monsoon precipitation. The land surface predictors used in the preliminary study are monthly aggregates from the 1950-2002 VIC archive. The retrospective archive includes gridded precipitation (P), mean surface air temperature (Ts), and Variable Infiltration Capacity (VIC) land surface model-derived soil moisture (Sm). The results of this analysis are reported in Zhu et al (2005). We found in extreme years that there may exist a precipitation - soil moisture – surface temperature land surface feedback mechanism which affects the Monsoon South summer precipitation. The pre-monsoon season (JFM and AM) precipitation shows the reverse relationship with summer monsoon in extreme years with dry (wet) monsoon preceded by wet (dry) winter and spring in SW USA and upper part of Northwestern Mexico. Spring soil moisture anomalies persist from the previous winter's precipitation anomaly (Fig. 2), and this soil memory negatively correlates with pre-monsoon surface air temperature, however the surface temperature anomalies generally do not persist to the onset of the monsoon (June). Instead, upper-tropospheric circulation appears to play the most important role in surface thermal conditions which affects the strength of the monsoon. As in normal years, our analysis to date has not shown a robust correlation of JJAS MS rainfall vs. JFM or AM precipitation, which is similar to our results for Monsoon West (Zhu et al, 2005). Over the next year, we plan to use advanced analysis techniques such as SVD to explore the relationship between pre-monsoon land surface conditions and monsoon precipitation in normal years.

Task 4: Uncertainty analysis. This task proposed to utilize methods like kriging to evaluate uncertainty in the gridded retrospective surface fields, and to determine regions and variables for which additional observations would be most valuable. We have not yet commenced work on this task.

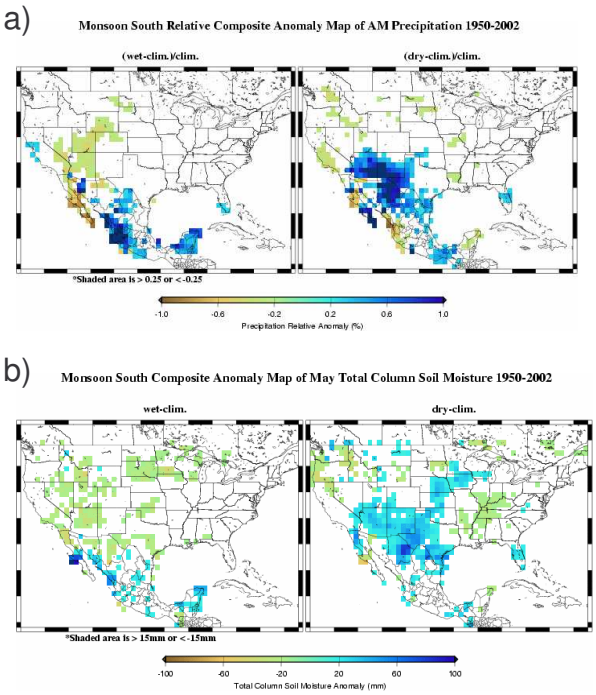

Figure 2: Monsoon south composite anomaly map a) Spring (AM) precipitation b) Spring (AM) soil moisture

References:

Zhu, C.M., D.P. Lettenmaier and T. Cavazos, 2004, Role of Antecedent Land Surface Conditions on North American Monsoon Rainfall Variability. *J. Climate.* (in press)

Papers sponsored by this research:

Zhu, C.M., D.P. Lettenmaier and T. Cavazos, 2004, Role of Antecedent Land Surface Conditions on North American Monsoon Rainfall Variability over Northwestern Mexico 1950-2002: a Study Based on a Long-Term Hydrological Dataset of Land Surface Fluxes and States for Mexico. *J. Climate.* (in preparation)

Presentations sponsored by this research:

Zhu C. M., Lettenmaier D.P., Cavazos T.,The Role of Antecedent Land Surface Conditions in Warm Season Monsoon Precipitation over Northwestern Mexico 1950-2002: a Study Based on a Long-Term Hydrological Dataset of Land Surface Fluxes and States for Mexico**,** AMS 85rd meeting, January 2005